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# DIRECT TENSION TEST FOR ASPHALTIC CONCRETE

*COMPUTER PROGRAM DOCUMENTATION and USER'S GUIDE*

MATERIALS INFORMATION
ENGINEERING MATERIALS OFFICE

# DIRECT TENSION TEST FOR ASPHALTIC CONCRETE
## COMPUTER PROGRAM

**Part 1: DOCUMENTATION**
**Part 2: USER'S GUIDE**

by

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# TECHNICAL REPORT DOCUMENTATION PAGE

## DIRECT TENSION TEST for ASPHALTIC CONCRETE
COMPUTER PROGRAM DOCUMENTATION

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**Abstract:**

A computer application program has been developed to provide control for *direct tension test* execution, using a Materials Testing System (MTS Model 442-11). This specific testing station includes a 468 Test Processor, a Digital PDP-11/23 plus microcomputer and other peripheral equipment and devices.

After the initial test setup under load control, a user enters the information required by the program to trigger the start of testing routine. Subsequently, the program switches control to a stroke mode and generates the specified extension rate, performs data acquisition, processes and presents the acquired data in formatted displays, calculates test results, presents the data graphically, and finally saves the results to a disk file. The program enables the complete test to be run automatically.

The first part of this report documents the procedure, control functions, and the most essential elements of the program. Appendices contain information which enable programmers to make changes to the program if necessary.

The second part provides the user with a program and all necessary guidance for the test procedure. Although the procedure looks quite simple, the program should only be used by technicians who have good knowledge of the test.

**Abrégé:**

On a mis au point un programme d'application sur ordinateur permettant de contrôler le déroulement de *l'essai de traction directe* à l'aide d'un système d'essai des matériaux (modèle MTS 442-11). Le poste d'essai est composé d'un processeur d'essai 468, d'un micro-ordinateur Digital PDP-11/23 plus, ainsi que d'autres unités et matériels périphériques.

Après la préparation initiale de l'essai, sous charge contrôlée, l'utilisateur entre les données dont le programme a besoin pour amorcer l'essai. Le programme passe ensuite au mode course et applique la traction spécifiée, il saisie, traite et met en forme les données, calcule les résultats de l'essai, présente les données sous forme de graphique, et sauvegarde les résultats sur disquette. Le programme rend l'essai entièrement automatique.

La première partie du rapport décrit la procédure, les fonctions de contrôle et les éléments les plus importants du programme. On trouvera dans les annexes des renseignements permettant aux programmeurs de modifier le programme, le cas échéant.

L'usager trouvera en seconde partie le programme et tous les renseignements nécessaires pour effectuer l'essai. Bien que la procédure semble simple, seuls les techniciens connaissant bien l'essai devraient utiliser le programme.

**Keywords:** Computer program, direct tension, tensile strength, asphalt mixes, servo-hydraulic, automated laboratory testing, data acquisition, program documentation, user's guide.

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# CONTENTS

**PART 1**


1. INTRODUCTION . . . . . 1

2. TEST OUTLINE . . . . . 1

3. PROGRAM PREREQUISITES AND LIMITATIONS . . . . . 2
   3.1. HARDWARE AND INSTRUMENTATION REQUIREMENTS . . . . . 2
   3.2. TEST ASSUMPTIONS . . . . . 2
   3.3. LIMITATIONS . . . . . 3
   3.4. SUPPLEMENTAL INFORMATION . . . . . 3

4. PROGRAM CONTROL FUNCTIONS . . . . . 4
   4.1. LOADING GENERATION MODEL . . . . . 4
   4.2. CONTROL PROCESS . . . . . 4

5. IN-LINE DATA ACQUISITION AND PROCESSING . . . . . 5

6. CALCULATIONS . . . . . 6

7. HARD DISK STORAGE . . . . . 7

8. INTERPRETATION OF PROGRAM OUTPUT . . . . . 8

9. COMMON PROBLEMS AND TROUBLESHOOTING . . . . . 8


**PART 2**


1. DESCRIPTION OF TEST MENU ITEMS . . . . . 11

2. INSTRUCTIONS FOR THE USER'S INPUT . . . . . 11
   2.1. GENERAL . . . . . 11
   2.2. 'IDENTIFY SAMPLE' SCREEN . . . . . 12
   2.3. 'DETERMINE TEST SPECS' SCREEN . . . . . 12

3. USER'S CONTROL OVER THE TESTING PROCESS . . . . . 13

4. PROGRAM OUTPUT . . . . . 14
   4.1. SCREEN OUTPUT DURING TESTING . . . . . 14
   4.2. SCREEN OUTPUT ON COMPLETION OF A TEST . . . . . 16
   4.3. TESTING RESULTS . . . . . 17

5. USER'S INPUT AND PROGRAM OUTPUT . . . . . 17

**APPENDICES TO PART 1:**

- A - DESCRIPTION OF VARIABLES USED IN THE PROGRAM
- B - DIRECT TENSION TEST LOADING PATTERN
- C - THE PROGRAM CODE LISTING

**APPENDIX TO PART 2:**

- D - EXAMPLES OF PROGRAM INPUT AND OUTPUT

# PART 1

# DOCUMENTATION

## 1. INTRODUCTION

This report provides a brief outline of the direct tension test and details the computer software program for the test in two parts i.e. *Part 1 - Program Documentation* and *Part 2 - User's Guide*.

The documented program is developed for the type of equipment set up in the Ministry Bituminous Evaluation Laboratory. The system consists of the MTS testware package with the Digital MicroPDP-11 computer. The program controls, executes and performs all the functions of the direct tension test including data acquisition, calculations, presentation of results, etc..

The direct tension test is one of the tools used for evaluating the fracture potential of bituminous mixes. For example, the results in terms of tensile strength can be utilized for determining the mix resistance to thermal cracking at low temperatures. Low-temperature performance can be viewed as a function of energy induced in a mix by load and thermal stresses over time.

The fracture energy, being the sum of creep energy and elastic energy, is frequently used in the study of time-stress dependent fracture. The direct tension test results provide means for such a study apart from being used for evaluating material strength at tension. The tensile strength of viscoelastic and/or thermoplastic materials is highly dependent on the test temperature and the rate of extension.

The program was first run in February 1988. Since then, some minor changes to the program were made to accommodate additional needs. So far, tests were carried out at temperatures ranging from +25°C to -35°C, with extension rate ranging from .09 mm/h to 305 mm/h.

## 2. TEST OUTLINE

Complete description of the test procedures can be found in the "Bituminous Material Characterization Manual" published previously by Engineering Materials Office, MTO, in 1987 (reference: The Asphalt Institute Research Report 73-1).

The following briefly outlines what is involved in the test:

A test specimen of approximate size of 76 × 76 × 102 mm, with the top and bottom surfaces fixed to steel end-plates using a 24-hour epoxy glue, is conditioned to a specified test temperature. For test temperature other than room temperature, the specimen is tested inside an environmental chamber. The specimen is pulled at a

predetermined extension rate until fracture occurs or when the load drops below the specified 2.5% of the full scale load value.

The program monitors channel 1 of the Micro Segment Generator to acquire stroke data points at an even intervals of .001 n.e.u. (normalized engineering units). In addition, load and strain data are read at every stroke data reading. The running maximum and minimum load values are recorded. Acquired data are presented both in tabular and graphical format for analysis by the user. Test results to report are:

- ultimate tensile load,
- mix stiffness at the ultimate load.

## 3. PROGRAM PREREQUISITES AND LIMITATIONS

### *3.1. HARDWARE AND INSTRUMENTATION REQUIREMENTS*

Microcomputer PDP-11/23-PLUS or LSI-11/23, mass storage device (min. 10 MB), system controlling terminal VT240 and MTS 468.10 test processor including a Micro Segment Generator are involved.

The test requires two custom made end-plates and a bonding agent (glue) to ensure uniform application of tensile load over the specimen cross-section. The pulling rods must be firmly attached to the end-plates so that there is not any significant (in relation to the range of extension expected) play involved during testing. The pulling is uniaxial and the rods must be kept firmly in place by the lower and upper grips of the servo-hydraulic machine. Vertical alignment of the specimen fixture is of primary importance for the success of the test.

The test requires an appropriately calibrated instrument (e.g. extensometer, LVDT) for precise measurement of the vertical strain of the specimen. All instruments attached to the specimen must be locked in place and seated firmly for the duration of the test. Both load cell and the load controller range cartridge must be capable of handling the anticipated tensile load. For better accuracy of test results, the applied load should be at least 10% of the load cell capability. The range of stroke controller cartridge and the range of LVDT or extensometer employed should be selected, so that the anticipated specimen extension would not be lower than about 10% of the controlled range.

### *3.2. TEST ASSUMPTIONS*

Careful preparation of test specimens is essential for obtaining valid results. Ideally, the specimen should have all its surfaces cut from a block/beam using a diamond blade

masonry saw. Thorough visual examination of the specimens should be made before using them for testing to ensure that specimens are free of cracks, damaged edges, or deformed/distorted surfaces.

In order for the program to function properly and to produce repeatable results, the following assumptions are made:

- the specimen is structurally coherent, uniform in composition, and regular in shape;
- the specimen temperature is kept constant for the duration of the test;
- the specimen is pulled uniaxially by means of a precisely aligned pair of endplate-rod fixtures;
- there is no "glue-plane" failure at the contact surfaces between the plate and the specimen;
- the bonding medium (e.g. a glue) is not expandable relative to the specimen material.

### *3.3. LIMITATIONS*

The program requires users to have some knowledge and experience of the test.

Most of the limitations are related to the test controlling hardware, e.g. range cartridges, controlled temperature cabinet, extensometers.

The range cartridges for both load control and stroke control must be selected so that the load and displacement do not exceed the allowable maximums under the specific test conditions. On the other hand, the cartridges must be able to give the desired data accuracy.

A theoretical lower limit for the extension rate is approximately 0.003 mm/h (with ±12.7mm range cartridge). But at this rate, the stroke simply will jump by 0.0015mm every half an hour. In practice, an extension rate of around 0.075 mm/h is considered workable for bituminous mixes.

### *3.4. SUPPLEMENTAL INFORMATION*

The duration of execution time for the test is variable, depending largely on the test temperature, rate of extension, and type of mix. The execution time could range from several seconds to several hours; this is in addition to the time needed for specimen conditioning prior to testing.

The program was designed primarily for testing of asphalt mixtures. However, it could be used for testing other viscoelastic materials when load pattern is found suitable.

# 4. PROGRAM CONTROL FUNCTIONS

## *4.1. LOADING GENERATION MODEL*

A tension is generated in the test specimen by using **FGRAMP** function under STROKE control. This function increases the uniformity of the stroke and ensures the greatest possible accuracy within the system resolution. The stroke rate is defined by two parameters: the ramp time and the stroke level.

The time parameter is limited to the system of 2000s. Thus, at very low extension rates, e.g. 0.2 mm/h, the generated functions could be used repeatedly for several times to bring the specimen to failure. This is illustrated in Appendix B.

## *4.2. CONTROL PROCESS*

Mode switch control is a specific feature of this automated procedure. The automatic switching from load control - used initially for the test setup - to stroke control enables the whole testing process to be carried out without operator's intervention. The mode selection is made by the Mode Switch Box included in the system hardware. Switching is possible only if the Switch Box is set at the REMOTE position.

A load zeroing routine is included in the mode switching program. Immediately after switching to the stroke control, but prior to the start of the extension, the load level is brought to zero. This removes any residual stresses from the specimen due to the mode switching.

This test is a STROKE controlled process. The stroke ramp generated in the program is combined with the extension rate and ramp time to keep the 'ramp step' (F0) to an optimum value in relation to the system resolution. When the extension rate has been decided, the following three ranges of ramp time can be established for testing:

| RAMP TIME s | EXTENSION RATE (R) mm/h |
|---|---|
| 1800 (0.5 x 3600) | R <= 10 |
| 180 (0.05 x 3600) | 100 > R > 10 |
| 18 (0.005 x 3600) | R => 100 |

For example, with an extension rate of 0.2 mm/h and using the range stroke cartridge of ± 12.7mm, the ramp time is set at 1800 s. The corresponding stroke level step, i.e. level reached within 1800 s, is: $F0 = 0.5 \times 0.2 / 12.7 = 0.008$ n.e.u..

## 5. IN-LINE DATA ACQUISITION AND PROCESSING

Three data acquisition routines are in progress during the test as shown in the table below.

| PROCESS NO. | PROCESS ID. | FUNCTION | MASTER CHANNEL | SLAVED CHANNELS |
|---|---|---|---|---|
| 1 | ADLEVEL | Detects and stores in array A1(,) signal amplitude level crossings at intervals defined by band width B1 (set at 0.001 in the program), in the specified channels. | 2 | 1 , 5 |
| 2 | ADRMAX | Detects and stores in an array A2(,) the running maximum signal level reached at the specified master channel, and the corresponding signal levels detected the same time at the slaved channels. | 2 | 1 , 5 |
| 3 | ADRMIN | Detects and stores in array A3(,) the running minimum signal level reached at the specified master channel, and the corresponding signal levels detected the same time at the slaved channels.<br>***NOTE: This process starts only after the load signal level has reached an arbitrarily set triggering value of 0.03 n.e.u.*** | 2 | 1 , 5 |

The number of stroke data levels in process No. 1 is limited by the program to 750 (array A1). Error message will appear and the data acquisition process stop when this number is exceeded during a test.

**NOTE**

*The width of stroke band (B1) used in ADLEVEL function predetermines the number of data points acquired during a test. The higher is the B1, the lower the number of points. The B1 value can be changed (line 1520 in the program listing) to suit the requirements. However, B1 must be higher than the stroke NOISE band but low enough to provide a sufficient number of data points for acquisition.*

*Another very important feature in the test control is the setting of appropriate LOAD limiting values (originally set to 0.03 and 0.025) which trigger the startup point and the end of a test (specimen failure). Too narrow an interval, i.e. within the LOAD NOISE band limits, will cause the following:*

- *premature breaking of a specimen,*
- *endless looping in the program,*
- *still display and unsatisfactory data acquisition.*

*The program lines affected by the two values are: 1660 to 1680, 1750, 1790, 1820.*

*A good prediction of the strength of a specimen and overall experience with the test will help in establishing the proper values for the limiting load.*

When a load signal level exceeds the value of 0.03 n.e.u., the elapsed time since the start of a test is shown on the screen and remains on display until the end of a test.

The only data processing performed during the test is a continuous comparison of current load level to the critical values specified in a test. This involves data conversion from binary to normalized engineering units.

Immediately after receiving the termination signal of a test, either automatically or by user-activated break, the program reads amplitudes at the active channels, records the time, and stops all function generation and data acquisition processes. The machine actuator rod is then forced down to a position of 75% full stroke in order to break the specimen (if it is not yet the case), and to expose the fractured surfaces of the specimen.

## 6. CALCULATIONS

The following computations are performed using the data acquired at stroke amplitude levels as defined by the load band width (B1) set in the program. The symbols used in these equations are explained under the description of variables. All stroke values are in mm, and strain values in microstrain.

$$Q1 = A0 \times C1, \quad \text{where: } A0 = \sum_{i=1}^{c} A1(c,0)$$

Time elapsed since the start of a test, s.

**Q2 = (ELEVEL(A1(0,1)) - ELEVEL(A1(0,1))) × L1 × 10**

Current LOAD value, N.

**Q3 = (ELEVEL(A1(0,2)) - ELEVEL(A1(0,2))) × M1 × 10**

Current STROKE value, mm.

**Q4 = (ELEVEL(A1(0,3))-ELEVEL(A1(0,3))) × M2×Z0×10**

Current STRAIN value, μstrain.

**Q5 = 1000 × Q2 / A5**

Current stress, kPa.

**Q6 = 1000 × Q5 / Q4**

Current stiffness, MPa.

Also, stiffness at ultimate load is calculated as follows:

$$U0 = \frac{10^6 \times L1 \times ELEVEL(A2(1,1))}{A5 \times M2 \times Z0 \times (ELEVEL(A2(1,3)) - ELEVE}$$

where ELEVEL is a unit conversion function in MTS BASIC language.

## 7. HARD DISK STORAGE

A hard copy of test results can be obtained as soon as a test is completed. Results can also be saved in a file on the hard disk. Select 'SAVE TEST RESULTS' item from the test menu for filing the results to a disk. The name of the file is assigned automatically and shown on the screen. A message 'TEST RESULTS ARE SAVED ALREADY!' is displayed when the results were saved previously. Saved data can be transferred to a database later at a convenient time, or recalled for viewing/printing (using the RT-11 system utility) as required.

Normally, the data items listed below are saved for each single direct tension test.

| | |
|---|---|
| 1__J$(5) | Test identification code |
| 2__T4 | Consecutive number of the direct tension test results about to be saved |
| 3__D$ | The system date returned by DAT$ function (DD-MM-YY) |
| 4__J$(2) | Specimen identification code |
| 5__J$(3) | Date of the sample (sampling or preparation) |
| 6__J$(4) | Mix design identification code |
| 7__J$(7) | Test specimen height, mm |
| 8__J$(8) | Test specimen width, mm |
| 9__J$(1) | Pavement sample identification code |
| 10__J$(9) | Test specimen mass, kg |
| 11__J$(10) | Distance from pavement edge/curb, m |
| 12__L$(4) | Load calibration factor, N/V |
| 13__L$(2) | Stroke calibration factor, mm/V |
| 14__L$(6) | Strain calibration factor, mm/V |
| 15__??? | 0.0 (Reserved) |
| 16__L$(3) | Test temperature, °C |
| 17__L$(7) | Test humidity, % |
| 18__L$(1) | Specified extension rate, mm/h |
| 19__J$(6) | Test specimen cross-sectional area, $mm^2$ |

| | |
|---|---|
| 20__L$(5) | Spacing between the LVDT clamps, mm |
| 21__L1$ | Ultimate tensile load recorded during the test, kN |
| 22__L2$ | Stroke recorded at the ultimate tensile load, mm |
| 23__L3$ | Strain recorded at the ultimate tensile load, µstrains |
| 24__L4$ | Stress calculated at the ultimate tensile load, kPa |
| 25__L5$ | Stiffness calculated at the ultimate tensile load, MPa |
| 26__L8$ | Load amplitude recorded at specimen failure, N |
| 27__L6$ | Stroke amplitude recorded at specimen failure, mm |
| 28__L7$ | Strain amplitude recorded at specimen failure, µstrains |
| 29__T9 | Time elapsed since the start of the test (= test duration), s |
| 30__M4$ | NOTES entered by the user in the Test Report (four strings) |

The end of file is marked with '{{0}}' string.

## 8. INTERPRETATION OF PROGRAM OUTPUT

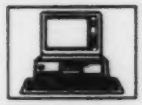
If the program output - including all screen displays, plotted graphs, tables of results - appears not in order, it is highly probable that the test has not been carried out properly and the results are not correct. Careful observation of Data Display indicators during testing can help determining how the test has been running.

A hard copy of the results should be obtained immediately after each test for examination of data, while the details of the test are fresh in the mind of the operator and the data are still in the computer memory ready for retrieval.

The results of a single direct tension test must always be interpreted with caution due to the complex nature of bituminous materials, imperfections in specimen preparation and in the test setup (alignment, conditioning, temperature control). The results should be analyzed on the basis of multiple results produced by the same mix type and test conditions.

## 9. COMMON PROBLEMS AND TROUBLESHOOTING

The direct tension test is a sensitive test and it requires great care to perform; even an experienced technician could encounter problems. While it is not possible to list all factors and situations which could lead to potential problem, the following could help in avoiding some of the common pitfalls.



| | | |
|---|---|---|
| a) | The 'glue plane' failure during testing or prior to testing. | THE ANTICIPATED TENSILE STRENGTH IS NEVER REACHED AND DATA ACQUISITION IS NOT TRIGGERED AT EXPECTED TIME. |
| b) | Invisible (hidden) crack(s) in the specimen. | THIS CAN BE CAUSED BY ACCIDENTAL SPECIMEN OVERLOAD DURING THE SETUP OF THE TEST, RESULTING IN CONSEQUENCES AS IN (A) ABOVE. |
| c) | Accidental mishandling of instrumentation or specimen during testing. | MAY RESULT IN BREAKING THE SPECIMEN, FALSE READINGS AT ONE OR MORE CHANNELS, ETC.. |
| d) | Working range exceeds the MTS cartridges limits. | MAY RESULT IN PERMANENT DAMAGE TO THE SPECIMEN (UNRECOVERABLE DEFORMATION OR BREAKING); TEST IS NOT COMPLETED. |
| e) | Errors in data input, e.g. wrong calibration factors. | ERRONEOUS RESULTS WILL OCCUR. |
| f) | Vibration of the laboratory floor and the MTS machine caused by external sources. | MAY RESULT IN A SERIES OF ERRONEOUS READINGS AND/OR IN PERMANENT DISPLACEMENT OF MEASURING INSTRUMENT(S). |
| g) | Power failure during the test or shortly after. | MAY RESULT IN DAMAGE TO THE SPECIMEN OR IN THE LOSS OF TEST RESULTS OR BOTH. |
| h) | Grips fail to hold the rods firmly in place (when load is at the upper limit of range cartridge used). | IN THIS SITUATION THE GRIP SLIPPAGE COULD OCCUR AND TEST COULD NOT BE COMPLETED SUCCESSFULLY. |

PART 2

# USER'S GUIDE

## 1. DESCRIPTION OF TEST MENU ITEMS

In order to ensure proper testing, the program must be accessed sequentially starting from item No. 1 of the menu. Also, it is recommended that the program and load be started anew for each direct tension test.

① **IDENTIFY SAMPLE**

Accepts data entry for sample identification and description.

② **DETERMINE TEST SPECS**

Accepts data entry for test specifications.

③ **RUN THE TEST**

Invokes the program procedure for engaging the MTS servo-hydraulic hardware and starting the automatic test process, including stroke function generation, data acquisition and all required real-time data processing. Test results are presented in a table format.

④ **PLOT THE GRAPH**

Presents test results in a graphical format (two screens).

⑤ **PRINT TEST REPORT**

Displays the summary of test results in a screen.

⑥ **SAVE TEST RESULTS**

Saves the essential test results to a disk file.

⑦ **QUIT THE PROGRAM**

Exits the program. Testing information remains accessible so long as no new program is loaded or the system will not shut down.

## 2. INSTRUCTIONS FOR THE USER'S INPUT

### *2.1. GENERAL*

- To quit data entry at any time, type ? + ↵ instead of normal entry. The program will return to the menu screen.
- To correct any single data item - follow on-screen instructions given after completing the data entry for a current data entry screen.

- To change the whole set of entered data or major part of it - recall the relevant data entry screen and enter your correct data.
- To clear all data variables in computer memory - exit the program and load it anew.

There are two steps in data input to the program:

❒ sample identification and description,

❒ test specifications.

### *2.2. 'IDENTIFY SAMPLE' SCREEN*

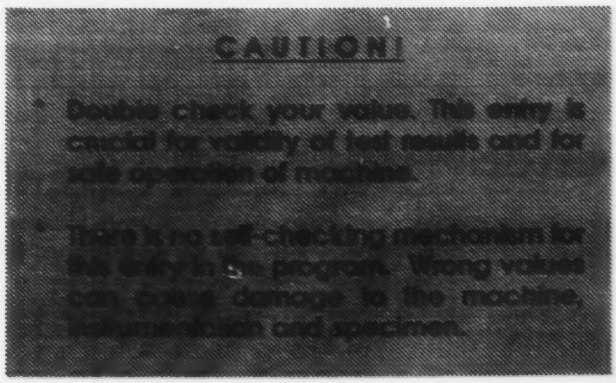
Entries 1 through 5 are predetermined by formats as defined in database application. They should be followed strictly to ensure compatibility with the database. The symbols in the formats shown in the Appendix are explained in the report entitled "*SOFTWARE FOR AUTOMATED TESTING OF ASPHALT MIXES. Documentation and Guide*".

The next four items (6 to 9) characterize the size and mass of the test specimen. They must be entered in conformity with the specified units and the results of relevant measurements. The last item (10) determines the location of sample material within the pavement width in relation to the right-hand edge (shoulder) of the pavement. This is not applicable to those specimens which do not originate from a pavement. In such a case, enter **0.00** at item No. 10.

### *2.3. 'DETERMINE TEST SPECS' SCREEN*

*Extension Rate, mm/hr*

Enter specimen extension rate in mm/hr as required. Although there is no any specific range limitation for this entry in general, practical limits depend on the resolution of the test Micro Segment Generator and a range cartridge used for testing. This entry can range from about .01 mm/hr up to even several thousand of mm/hr.



*Stroke calibration factor, mm/Volt*

Enter appropriate value for the range of MTS stroke cartridge used by referring to the table of values in the report entitled "*SOFTWARE FOR AUTOMATED TESTING OF ASPHALT MIXES. Documentation and Guide*".

*Test temperature, °C*

Enter the temperature of the specimen to be kept constant during testing.

*Load calibration factor, N/V*

Enter appropriate value for the range of MTS load cartridge used by referring to the table of values in the report entitled "*SOFTWARE FOR AUTOMATED TESTING OF ASPHALT MIXES. Documentation and Guide*".

*Spacing between LVDT clamps, mm*

Enter the effective specimen length (height) between the LVDTs or other types of distance sensing instrument used for the purpose of measuring the vertical strain during testing.

*Strain calibration factor, mm/Volt*

Enter the calibration factor determined for the type of LVDTs or other instrument used in the test.

*Test humidity, %*

Enter the value of relative air humidity around the specimen during the test.

## 3. USER'S CONTROL OVER THE TESTING PROCESS

When all of the required input data are entered and hardware elements and specimen are properly set up, it is ready to start the automatic testing process.

Select item ③ from the test menu by referring to p. 4.1 (SCREEN 1).

Now, the system is ready for the final check before testing. Follow the on-screen instructions. If, for some reason, the system does not switch to a stroke control, a flashing message will appear at the bottom of the screen i.e. **MODE SWITCH FAILED**. In such a case find out the cause of failure and touch the *Return* key to invoke the mode switching. If problem persists, it is better to exit the testing procedure by entering an escape sequence: **ESC-Q**.

Immediately after switching to STROKE control, the system is expected to zero the load. A message as shown under SCREEN 2 in p. 4.1 will appear. After the load is zeroed, another message appears on the screen (see p. 4.1, SCREEN 3). Start the test by entering

**'GO' + ↵**

The test is performed automatically and intervention to the test is possible through the following control options:

- To STOP the test at any time, or exit the test procedure prior to starting the test (i.e. before typing **'GO'**), touch:

ESC or Q

The program will return to the test menu screen.

- To BREAK a specimen and terminate the test, e.g. if it takes too long to reach a predefined specimen failure criterion after a maximum load is reached, touch:

ESC or B

In this last case, the test is considered complete.

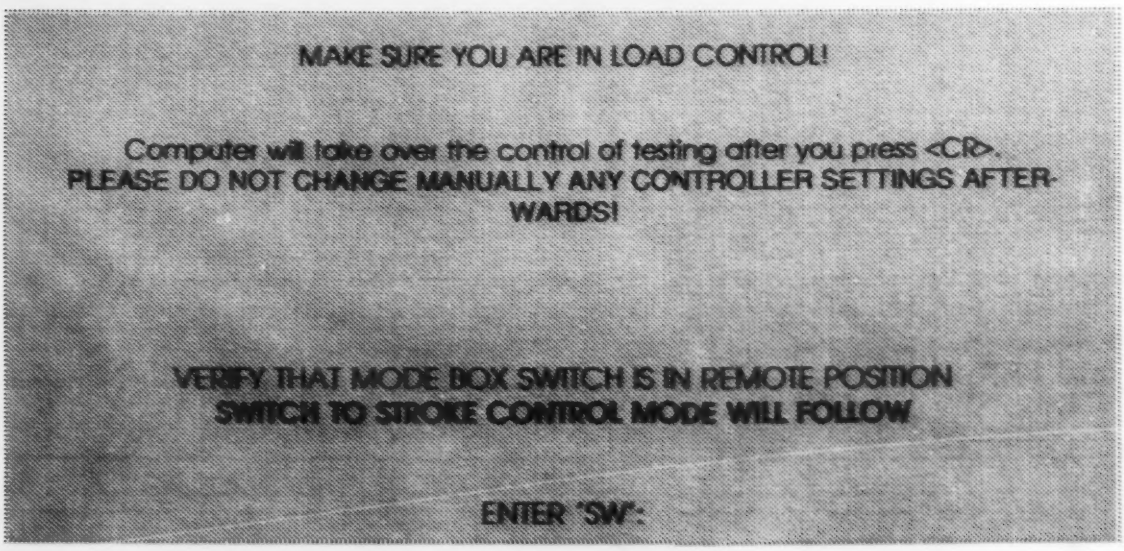
During the test, the MTS Data Display Unit, the Oscilloscope, or/and the Recorder/Plotter are possible to monitor the actual level of readings on any active channel(s) of particular interest.

## 4. PROGRAM OUTPUT

### *4.1. SCREEN OUTPUT DURING TESTING*

On-screen guidance is given throughout the test and messages are normally displayed as follows:

**SCREEN 1:**


MAKE SURE YOU ARE IN LOAD CONTROL!
Computer will take over the control of testing after you press <CR>.
PLEASE DO NOT CHANGE MANUALLY ANY CONTROLLER SETTINGS AFTER-WARDS!
VERIFY THAT MODE BOX SWITCH IS IN REMOTE POSITION
SWITCH TO STROKE CONTROL MODE WILL FOLLOW
ENTER 'SW':

**SCREEN 2:**

ZEROING THE LOAD - PLEASE WAIT...

**SCREEN 3:**

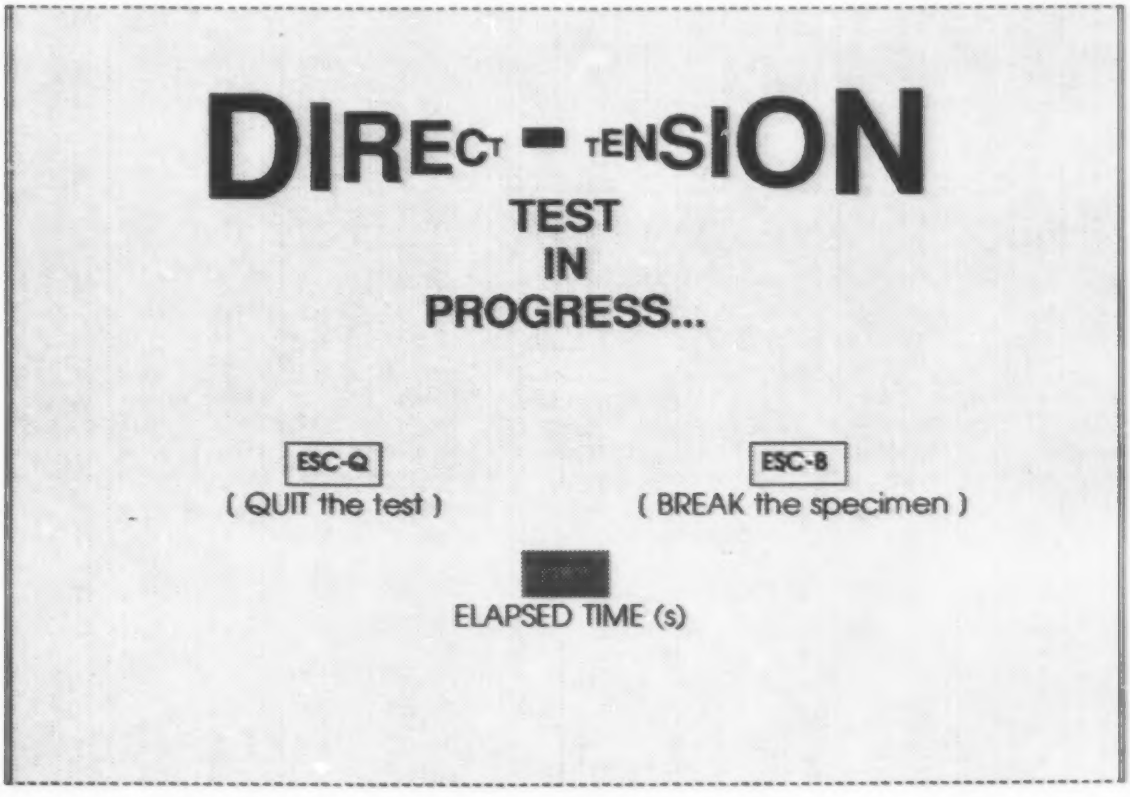
**THIS IS A STROKE CONTROLLED TEST**

VERIFY THAT THE CONTHOLLER SETTINGS ARE CORRECT
BE SURE THAT STROKE AND LOAD ARE ZEROED

The test is successful when the specimen does not crack before the load reaches 3% F. Scale. Failure is defined by a load reading of less than 2.5% F. Scale after load has exceeded 3% F. Scale (in tension).

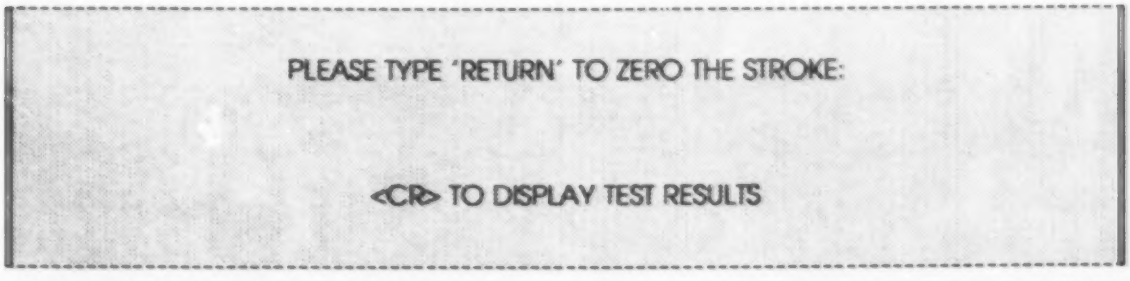
NOW LOAD IS ZEROED.
TO START TEST - ENTER 'GO':

**SCREEN 4:**

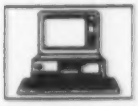



### *4.2. SCREEN OUTPUT ON COMPLETION OF A TEST*

As soon as the end of testing is reached, a brief summary ('NEWS IN BRIEF...') of test results is displayed as shown in Appendix D. Also, the following message is displayed:




At this point, before typing 'RETURN', it is advisable to remove the broken specimen from the machine for observation. The actuator rod is raised to the original position (at start of the test) within several seconds after entering the specified instruction.



### *4.3. TESTING RESULTS*

A summary of test results is displayed with the main data table. An example of the table is given in Appendix D. If there is not any data points, a flashing message appears:

> SORRY, NO RESULTS. TEST FAILED
>
> Press <CR> to get test menu, any other key to quit:

- ***GRAPHICS*** Selecting 'PLOT THE GRAPH' item from the test menu causes switching to a graphic mode and invoking graphic routine. All necessary scaling and labelling calculations are executed and the following two graphs are presented consecutively (just press ↵ to get the next graphics screen):

  ❶ *TENSILE LOAD vs TIME OF LOADING*

  ❷ *STRAIN vs TENSILE STRESS*

  After pressing ↵ the program exits from graphics to the test menu screen.

***TEST REPORT*** 'TEST REPORT' screen is displayed upon selection of 'PRINT TEST REPORT' item from the test menu. The format of a standard report is illustrated in Appendix C. It contains sample identification data, test specifications and relevant test results, i.e. the ultimate tensile strength and the stiffness at ultimate load. There is also space at the bottom of the screen for short notes/comments related to the test and specimen.

## 5. USER'S INPUT AND PROGRAM OUTPUT

Direct Tension test results are quite consistent from test to test for a given mix, test temperature and extension rate. Two examples (Appendix D) are used to illustrate the test procedure.

# DESCRIPTION OF VARIABLES USED IN THE PROGRAM

The list below identifies all variables which help to understand the structure of the program.

**NUMERIC VARIABLES (SCALARS)**

| NAME | DESCRIPTION |
|---|---|
| A0 | The number of clock interrupts since the start of ADLEVEL function |
| A1, A2, A3 | Array scalars in arrays A1(.), A2(.) and A3(.), respectively |
| A4 | Absolute difference between strain values acquired at the start of ADLEVEL function and at the specimen failure, mm |
| A5 | Specimen height, mm |
| A9 | Error code referring to the status of the file open for saving the test results |
| B1 | Load band width (= noise correction factor built into ADLEVEL function); originally set equal to .007 |
| C1 | Current clock setting in CKTIME function, seconds/interrupt |
| D9,M9,Y0 | Date (day, month, year) strings as returned by GDATE function |
| E | The specified specimen extension rate, mm/hr |
| E0 | Current amplitude of stroke returned by FGREAD function, n.e.u. |
| E1 | The specified end-level amplitude at stroke channel for ramp generation (FGRAMP call), Eng. Volts |
| E7,E8,E9 | Current second, minute, hour, returned by GTIME function, respectively |
| F0 | Assigned expression value; step by which the end-level value of stroke is increased in consecutive calls to FGRAMP function, Eng. Volts |
| I1 | Number of data entry items in the first data entry screen (sample id.) |
| I2 | Number of data entry items in the second data entry screen (test specs) |
| K1 ÷ K9 | Assigned expression values used for coding the day of the week |
| L1 | Load calibration factor, N/V |
| M1 | Stroke calibration factor, mm/V |
| M2 | Strain calibration factor, mm/V |
| M8 | Value returned after MODESW function, representing the status of the attempted mode switch |
| Q1 | Time elapsed since the start of data acquisition, s |

| | |
|---|---|
| Q2 | Load data point (ADLEVEL function) acquired at specified stroke level, N |
| Q3 | Stroke data point (ADLEVEL function) acquired at specified band level, mm |
| Q4 | Strain data point (ADLEVEL function) acquired at specified stroke level, µstrains |
| Q5 | Stress calculated at the specified stroke level, kPa |
| Q6 | Stiffness (Q5/Q4) calculated at the specified stroke level, MPa |
| Q9 | The last strain value acquired with ADLEVEL function, µstrains |
| R1 | Flag indicating the tensile load has reached 3% F.S. (full scale); set to 1 |
| R8 | Same meaning as variable A0 |
| R9 | Time elapsed since the start of data acquisition using ADLEVEL function, s; same meaning as variable Q1 |
| S1 | Current stroke amplitude value (ADIMMED function), n.e.u. |
| T4 | Consecutive number of the Direct Tension test results as saved under "TSTC" file name |
| T9 | Time elapsed since the start of the test, s |
| U0 | Stiffness calculated at the ultimate load, MPa |
| U5 | Strain data point calculated at the specified stroke level, µstrains |
| V0 | The upper value for STRESS axle (vertical), calculated using the stress value at ultimate load, kPa |
| V1 ÷ V3 | Assigned expression values; in calculation of the STRESS axis scaling |
| V4 | Difference between the initial and current load recorded, N |
| V5 | Stress data point calculated at a specified stroke level, kPa |
| W1 | Stroke amplitude recorded (using ADIMMED) just before switching from LOAD to STROKE control, n.e.u. |
| W2 | Load amplitude recorded (using ADIMMED) just before switching from LOAD to STROKE control, n.e.u. |
| W3 | Stroke amplitude recorded (using ADIMMED) right after control mode switching (LOAD to STROKE), n.e.u. |
| W4 | Difference between stroke recorded before and after control mode switching, n.e.u. |
| W5 | Load amplitude recorded (using ADIMMED) after control mode switching, n.e.u. |
| W6 | The second value of stroke amplitude recorded (using ADIMMED) after control mode switching, n.e.u. |
| W7 | Current value of stroke returned by FGREAD call, n.e.u. |

| | |
|---|---|
| X0 | X-axis length (TIME), s |
| X1 ÷ X3 | Assigned expression values in calculation of the time axis scaling |
| Y0 | Y-axis length (LOAD), N |
| Y1 ÷ Y3 | Assigned expression values used in calculation of the load axis scaling |
| Z | X-axis length (STRAIN), µstrains |
| Z0 | Assigned expression value related to LVDT's clamps spacing, 1/mm |
| Z1 ÷ Z3 | Assigned expression values in calculation of the strain axis scaling |
| Z6 | Current load amplitude value (ADIMMED function), n.e.u. |
| Z7 | Current vertical strain value (ADIMMED function), n.e.u. |

**ARRAYS**

| NAME | DESCRIPTION |
|---|---|
| A1(750,3) | Stores readings of amplitudes acquired at specified channels during the test; used in ADLEVEL function. Format of the array: |

| Row Nº | Number of Interrupts Between Readings | Channel Nº | | |
|---|---|---|---|---|
| | | 2 (LOAD) | 1 (STROKE) | 5 (STRAIN) |
| 0 | | A1(0,1) | A1(0,2) | A1(0,3) |
| 1 | A1(1,0) | A1(1,1) | A1(1,2) | A1(1,3) |
| 2 | A1(2,0) | A1(2,1) | A1(2,2) | A1(2,3) |
| 3 | A1(3,0) | A1(3,1) | A1(3,2) | A1(3,3) |
| ... | ..... | ..... | ..... | ..... |
| 300 | A1(750,0) | A1(300,1) | A1(750,2) | A1(750,3) |

A2(1,3) Stores the maximum amplitude level recorded at specified channels since the start of the test; used in ADRMAX function. Format of the array:

| Number of Interrupts Since Last Change | Channel Nº | | |
|---|---|---|---|
| | 2 (LOAD) | 1 (STROKE) | 5 (STRAIN) |
| A2(1,0) | A2(1,1) | A2(1,2) | A2(1,3) |

A3(1,3) Stores the minimum amplitude level recorded at specified channels since the moment at which the amplitude at channel Nº 2 becomes greater then .03 (the triggering value); used in ADRMIN function. Format of the array:

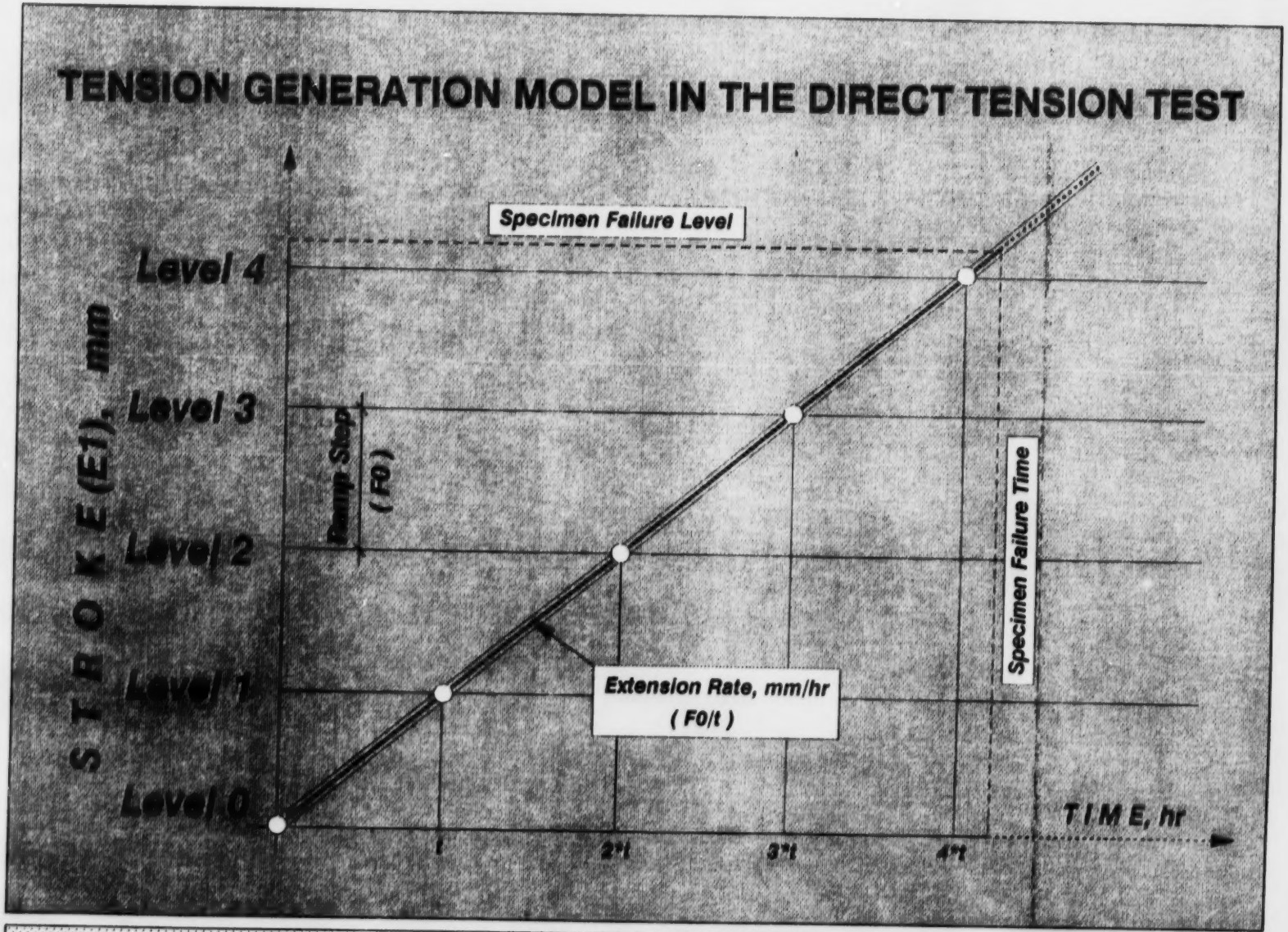
| Number of Interrupts Since Last Change | Channel Nº | | |
|---|---|---|---|
| | 2 (LOAD) | 1 (STROKE) | 5 (STRAIN) |
| A3(1,0) | A3(1,1) | A3(1,2) | A3(1,3) |

H3(10) Stores the consecutive numbers of relevant MTS-driven tests

**STRINGS AND STRING ARRAYS**

| NAME | DESCRIPTION |
|---|---|
| C$0 | The test menu item numbers |
| D$ | System date (dd-mmm-yy) |
| F2$ | The consecutive number of the Direct Tension test |
| H2$0 | Identification strings for MTS-driven tests |
| I$0 | Prompts used in sample identification data entry screen |

| | |
|---|---|
| J$0,J1$ | User's responses to the prompts in sample identification data entry screen |
| K$0 | Prompts used in test specifications data entry screen |
| K2$ | Day of the week |
| K3$0 | Substrings of the day of the week |
| L$0 | User's responses to the prompts in test specifications data entry screen |
| L1$ | Ultimate tensile load recorded during the test, kN |
| L2$ | Stroke recorded at the ultimate tensile load, mm |
| L3$ | Strain recorded at the ultimate tensile load, µstrains |
| L4$ | Stress calculated at the ultimate tensile load, kPa |
| L5$ | Stiffness calculated at the ultimate tensile load, MPa |
| L6$ | Stroke amplitude recorded at specimen failure, mm |
| L7$ | Strain amplitude recorded at specimen failure, µstrains |
| L8$ | Load amplitude recorded at specimen failure, N |
| M$0 | Test data items (results) saved to a disk file |
| M4$ | User's comment, if any, added after completion of the test under NOTES in the Test Report screen |
| O$0 | Test menu items |
| V1$ + V3$ | Day, month, year, in the test date representation |


TENSION GENERATION MODEL IN THE DIRECT TENSION TEST
Specimen Failure Level
Level 4
Level 3
Level 2
Level 1
Level 0
STROKE (E1), mm
Ramp Step (F0)
Extension Rate, mm/hr
( F0/t )
Specimen Failure Time
TIME, hr
t
2*t
3*t
4*t

# THE PROGRAM CODE LISTING



```
10 REM  --- DIRECT TENSION TEST --- September 1987 *** BY R. Raciborski
20 REM  ------------------------ Last update: February, 1992 ---------------------------
30 REM  ------------------------------------ RAE.BAS ------------------------------------
40 REM  ************************************************************************************
50 FGSTOP \ ADSTOP
60 KBINT("Q",1, LINE 2100 ) \ KBINT("B",1, LINE 1840 ) \ KBENB
70 CRT80COL \ CNFWRN(B) \ IF B=1 GO TO 90
80 GO TO 130
90 CLRTXWIN \ TXTSPOS(,12,4) \ TXTFLASH
100 PRINT "ERROR! CURRENT HARDWARE CONFIGURATION DOES NOT MATCH"
110 TXTSPOS(,13,29) \ PRINT "CONFIGURATION FILES" \ TXTNORMAL
120 ETIME \ SLEEP(10) \ GO TO 1320
130 DIM K3$(7),I$(12),J$(12),J1$(12),K$(10),L$(10)
135 M4$=""
140 I$(1)="PAVEMENT SAMPLE ID.(Format: A999999X99): "
145 I$(2)="SPECIMEN ID.(Format: AAX99XA999):          "
150 I$(3)="DATE OF SAMPLE (Format: MMDDYY):           "
155 I$(4)="MIX DESIGN ID.(Format: AA9999):            "
160 I$(5)="TEST ID.(Format: AA9999):                  "
165 I$(6)="SPEC.CROSS-SECT.(mm^2):                    "
170 I$(7)="SPECIMEN HEIGHT(mm):                       "
175 I$(8)="SPECIMEN WIDTH(mm):                        "
176 I$(9)="SPECIMEN MASS (kg):                        "
177 I$(10)="DISTANCE FROM PAVEMENT EDGE (m):          "
180 K$(1)="EXTENSION RATE(mm/hr):" \ K$(2)="STROKE CALIBRATION FACTOR(mm/V):"
190 K$(3)="TEST TEMPERATURE(C):" \ K$(4)="LOAD CALIBRATION FACTOR (N/volts):"
200 K$(5)="LVDT CLAMPS SPACING(mm):" \ K$(6)="STRAIN CALIBRATION FACTOR
    (mm/Volt):"
210 K$(7)="TEST HUMIDITY (%):"
220 T2$="*** DIRECT TENSION TEST ***" \ T3$="M E N U"
230 T2=INT((80-LEN(T2$))/2) \ T3=INT((80-LEN(T3$)))/2 \ P$="SELECT ITEM # FOR CHANGE"
240 E0$="ENTER ITEM NUMBER FOR CHANGE " \ T1$="CORRECT ENTRY IS = "
250 DATA 7,"<1>","IDENTIFY SAMPLE","<2>","DETERMINE TEST SPECS","<3>",
    "RUN THE TEST"
260 DATA "<4>","PLOT THE GRAPH","<5>","PRINT TEST REPORT","<6>","SAVE TEST
    RESULTS","<7>","QUIT THE PROGRAM"
270 I1=10 \ I2=7 \ K3$(1)="SUN" \ K3$(2)="MON" \ K3$(3)="TUES" \ K3$(4)="WEDNES"
280 K3$(6)="FRI" \ K3$(7)="SATUR" \ K3$(5)="THURS"
330 GO TO 1200
340 TEKMODE \ X0=INT(1.05*T9+.5) \ X1=INT(LOG10(X0/6)) \ X2=10^X1
350 X3=X0/(6*X2) \ X3=INT(X3) \ X3=X3*X2 \ Y0=INT(1.05*ELEVEL(A2(1,1))*L1*10)
360 Y1=INT(LOG10(Y0/5)) \ Y2=10^Y1 \ Y3=Y0/(5*Y2) \ Y3=INT(Y3) \ Y3=Y3*Y2
370 R8=0 \ R9=0 \ REM Same as A0,Q1
380 PHYL(1,0,100,0,100) \ SCALE(1,0,0,X0,0,Y0)
390 HOME \ PRINT CHR$(27)+'a'; \ LABEL(,"","",X3,Y3,2)
400 HOME \ PRINT CHR$(27)+'h'; \ AXES(1,0,0) \ AXES(1,X0,Y0)
```

```
410 LABEL(1,"T i m e (seconds)","TENSILE LOAD * N",X3,Y3,1)
420 FOR I=1 TO A1
424 R8=R8+A1(I,0 \ R9=INT(R8*C1*1000+.5)/1000 \ REM Time elapsed, s, since the start
    of ADLEVEL
426 MARK(1,5,R9,INT(ELEVEL(A1(I,1))*10*L1))
428 NEXT I
430 INPUT #0:R$ \ IF R$="" THEN VTMODE(1) \ GO TO 450
440 GO TO 430
450 TEKMODE
460 FOR I=1 TO A1 \ IF ABS(ELEVEL(A1(I,1)))>ABS(.97*ELEVEL(A2(1,1))) THEN I4=I \ I=A1 \
    NEXT I
470 IF I4>0 THEN IF I4<A1 THEN I=I4
480 A4=(Z7-ELEVEL(A1(0,3)))*10*M2*Z0 \ A4=ABS(INT(A4+.5)) \ Q9=Q4
490 Z=INT(1.05*A4+.5) \ IF Q9>Z THEN Z=INT(1.05*Q9+.5)
500 V0=10^3*ELEVEL(A2(1,1))*10*L1/A5 \ V0=INT(1.05*V0+.5)
510 V1=INT(LOG10(V0/5)) \ V2=10^V1 \ V3=V0/(5*V2) \ V3=INT(V3) \ V3=V3*V2
520 Z1=INT(LOG10(Z/6)) \ Z2=10^Z1 \ Z3=Z/(6*Z2) \ Z3=INT(Z3) \ Z3=Z3*Z2
530 PHYL(1,0,100,0,100) \ SCALE(1,0,0,Z,0,V0)
540 HOME \ PRINT CHR$(27)+'a'; \ LABEL(,"","",Z3,V3,2)
550 HOME \ PRINT CHR$(27)+'h'; \ AXES(1,0,0) \ AXES(1,Z,V0)
560 LABEL(1,"S t r a i n (microstrains)","Stress * kPa",Z3,V3,1)
570 FOR I=1 TO A1 \ V4=(ELEVEL(A1(I,1))-ELEVEL(A1(0,1)))*10*L1
580 V5=10^3*V4/A5 \ V5=INT(V5*100+.5)/100 \ U5=(ELEVEL(A1(I,3))-
    ELEVEL(A1(0,3)))*10*M2*Z0
590 U5=ABS(INT(U5+.5)) \ MARK(1,5,U5,V5) \ NEXT I
600 INPUT #0:R1$ \ IF R1$="" THEN VTMODE(1) \ GO TO 1200
610 GO TO 600
620 CLRTXWIN \ TXTSPOS(,2,35) \ TXTBOLD \ PRINT "TEST REPORT" \ TXTNORMAL
630 TXTSPOS(,3,7) \ PRINT "----------"
640 TXTSPOS(,4,7) \ PRINT "** DIRECT TENSION TEST **"
650 TXTSPOS(,4,50) \ PRINT "DATE OF TEST: "DAT$(D$)
660 TXTSPOS(,5,7) \ PRINT "----------" \ GOSUB 880
670 TXTSPOS(,5,50) \ PRINT K2$;" * "E9":"E8":"E7
680 TXTSPOS(,6,50) \ PRINT "TEST ID.: ";J$(5)
690 TXTSPOS(,7,7) \ TXTUNLINE \ PRINT "SAMPLE IDENTIFICATION" \ TXTNORMAL
700 TXTSPOS(,8,7) \ PRINT "1.PAVEMENT SAMPLE ID.:"TAB(23)J$(1)TAB(37)
    "5.DATE OF SAMPLE:"TAB(60)J$(3)
710 TXTSPOS(,9,7) \ PRINT "2.SPECIMEN ID.:"TAB(23)J$(2)TAB(37)"6.MIX DESIGN ID.: "
    TAB(60)J$(4)
720 TXTSPOS(,10,7) \ PRINT "3.SPECIMEN HEIGHT(mm):"TAB(23)J$(7)TAB(37)
    "7.SPEC.CROSS-S.(mm^2):"TAB(60)J$(6)
730 TXTSPOS(,11,7) \ PRINT "4.SPECIMEN WIDTH (mm):"TAB(23)J$(8)TAB(37)
    "8.SPECIMEN MASS (kg):"TAB(60)J$(9)
740 PRINT \ TXTSPOS(,13,7) \ TXTUNLINE \ PRINT "TEST PARAMETERS" \ TXTNORMAL
```

```
750 TXTSPOS(,14,7) \ PRINT "1.";K$(1)TAB(25)L$(1)TAB(37)"3.";K$(7)TAB(64)L$(7)
755 TXTSPOS(,15,7) \ PRINT "2.";K$(3)TAB(25)L$(3)TAB(37)"4.";K$(5)TAB(64)L$(5)
760 PRINT  \ TXTSPOS(,17,7) \ TXTUNLINE \ PRINT "TEST RESULTS" \ TXTNORMAL
770 TXTSPOS(,18,7) \ PRINT "1.ULTIMATE TENSILE LOAD (kN) =       "; \
    L1$=STR$(INT(ELEVEL(A2(1,1))*L1*10+.5)/1000)
780 TXTSPOS(,18,44) \ TXTBOLD \ PRINT L1$ \ TXTNORMAL
790 TXTSPOS(,19,7) \ PRINT "2.STIFFNESS AT ULTIMATE LOAD (MPa) = "; \ TXTSPOS(,19,43)
800 TXTBOLD \ PRINT USING "-#.####^^^^^",U0 \ TXTNORMAL
810 TXTSPOS(,21,7) \ PRINT "NOTES (<128 characters):";
820 INPUT #0:B1$ \ IF B1$="" THEN GO TO 850
830 M4$=M4$+B1$ \ IF LEN(M4$)>=127 THEN GO TO 850 \ REM M4$ is a Comment
840 GO TO 820
850 PRINT TAB(10)"HIT <RETURN> TO CONTINUE, ANY OTHER - TO QUIT"; \ INPUT #0:B1$
860 IF B1$<>"" GO TO 1290
870 GO TO 1200
880 D9=1900+VAL(V1$) \ M9=VAL(V2$) \ Y9=VAL(V3$)
890 K1=INT(.6+(1/M9)) \ K2=D9-K1 \ K3=M9+12*K1 \ K4=K2/100 \ K5=INT(K4/4)
900 K6=INT(K4) \ K7=INT((5*K2)/4) \ K8=INT(13*(K3+1)/5)
910 K9=K5-K6+K7+K8+Y9-1 \ K9=K9-(7*INT(K9/7))+1 \ K2$=K3$(K9)&"DAY" \ RETURN
920 CLRTXWIN
922 PRINT TAB(19)CHR$(27)&"#3";"DIRECT TENSION TEST"
923 PRINT TAB(19)CHR$(27)&"#4";"DIRECT TENSION TEST"
925 TXTSPOS(,4,60) \ PRINT "Date: "DAT$(D$) \ TXTSPOS(,5,60) \ GTIME(S9,M9,H9) \
    PRINT "Time: ";H9;":";M9
927 PRINT  \ TXTUNLINE \ PRINT "COMMENT:" \ TXTNORMAL
929 PRINT "* "; \ INPUT #0:C0$
930 IF C0$="" THEN PRINT "---------- end of user comment ----------
    ---"; \ GO TO 934
932 GO TO 929
934 INPUT #0:C0$
936 CLRTXWIN \ TXTSPOS(,3,30)\TXTUNLINE \ PRINT "SAMPLE IDENTIFICATION" \
    TXTNORMAL
938 FOR I=1 TO I1 \ TXTSPOS(,5+I,14) \ PRINT "(";STR$(I);")"TAB(5)I$(I); \ INPUT #0:J$(I)
940 IF J$(I)=CHR$(63) THEN 1200 \ NEXT I
950 J1=99  \ GO TO 1010
960 VTMODE \ CLRTXWIN \ TXTSPOS(,2,31) \ TXTUNLINE \ PRINT "TEST SPECIFICATIONS" \
    TXTNORMAL
970 FOR I=1 TO I2 \ TXTSPOS(,3+I,17) \ PRINT "(";STR$(I);")"TAB(4)K$(I)TAB(42);
980 INPUT #0:L$(I) \ IF L$(I)="?" THEN 1200
990 NEXT I
1000 J1=100
1010 TXTSPOS(,18,31) \ TXTINVERS \ PRINT "ANY CHANGES?(Y/N): "; \ TXTNORMAL
1020 INPUT #0:R$ \ IF R$<>"Y" THEN IF R$<>"N" THEN 1010
1030 IF R$="N" THEN 1130
```

```
1040 TXTSPOS(,20,26) \ PRINT P$+": "; \ INPUT #0:I
1050 IF I<1 GO TO 1120
1060 IF I>11 GO TO 1120
1070 TXTSPOS(,22,28) \ TXTINVERS \ IF J1=100 THEN 1160
1080 PRINT T1$; \ TXTNORMAL \ INPUT #0:J1$(I) \ IF LEN(J1$(I))>=1 THEN J$(I)=J1$(I)
1090 CLRTXWIN \ TXTSPOS(,3,30) \ TXTUNLINE \ PRINT "SAMPLE
     IDENTIFICATION" \ TXTNORMAL
1100 FOR I=1 TO I1 \ TXTSPOS(,4+I,14) \ PRINT "(";STR$(I);")"TAB(5)I$(I);J$(I) \ NEXT I
1110 GO TO 1010
1120 TXTSPOS(,21,24) \ TXTINVERS \ PRINT E0$ \ TXTNORMAL \ GO TO 1040
1130 TXTSPOS(,23,23) \ PRINT "HIT <RETURN> TO PROCEED WITH TEST"; \ INPUT #0:B1$
1140 IF B1$<>"" GO TO 1130
1150 CLRTXWIN \ GO TO 1200
1160 TXTSPOS(,22,28) \ TXTINVERS \ PRINT T1$; \ TXTNORMAL \ INPUT #0:L$(I)
1170 CLRTXWIN \ TXTSPOS(,2,31) \ TXTUNLINE \ PRINT "TEST SPECIFICATIONS" \
     TXTNORMAL
1180 FOR I=1 TO I2 \ TXTSPOS(,3+I,17) \ PRINT "(";STR$(I);")"TAB(4)K$(I)TAB(42)
     L$(I) \ NEXT I
1190 GO TO 1010
1200 RESTORE  \ READ N5
1210 SETDIM C$(N5),O$(N5)
1220 FOR I=1 TO N5 \ READ C$(I),O$(I) \ NEXT I
1222 CLRTXWIN \ PRINT CHR$(27)+'P1p';'S(I0,E,C0)W(I2,N0,P1,M1,F3,V,S0)'
1223 PRINT "P(0,0)V(B)(+799)(,+479)(-799)(,-479)(E)"
1224 PRINT "P(30,240)V(B)(+240,-222)(+260)(+239,+222)(-239,+220)(-260)(-240,-220)(E)"
1225 PRINT "P(30,210)V(B)(,-192)(+210)(-210,+192)(E)P(560,18)V(B)(+209)(,+192)
     (-209,-192)(E)"
1226 PRINT "P(30,270)V(B)(+210,+190)(-210)(,-190)(E)P(560,460)V(B)(+209,-190)
     (,+190)(-209)(E)"
1227 PRINT CHR$(27)+'\';
1230 TXTSPOS(,4,1+T2) \ TXTINVERS \ TXTBOLD \ PRINT T2$ \ TXTNORMAL
1240 TXTSPOS(,7,1+T3) \ TXTUNLINE \ PRINT T3$ \ TXTNORMAL
1250 FOR I=1 TO N5 \ TXTSPOS(,8+I,29) \ PRINT C$(I);" ";O$(I) \ NEXT I
1260 TXTSPOS(,19,30) \ PRINT "Your Choice (Enter #): "; \ INPUT #0:B
1270 ON B GO TO 920,960,1450,340,620,2560,1290
1280 TXTSPOS(,22,25) \ PRINT "THAT'S NOT AVAILABLE, TRY AGAIN" \ GO TO 1260
1290 CLRTXWIN \ PRINT  \ PRINT TAB(30)"ARE YOU SURE?(Y/N) "; \ INPUT #0:R$
1300 IF R$="N" THEN 1200
1310 IF R$<>"Y" THEN 1200
1320 CLRTXWIN \ GO TO 2810
1360 PRINT CHR$(27)+"P1p";"S(I0,E,C0)W(I2,N0,P1,M1,F3,V,S0)P(57,40)"
1370 PRINT "T(S8)'D'P(129,48)T(S7)'I'P(192,55)T(S6)'R'P(246,63)"
1380 PRINT "T(S5)'E'P(291,70)T(S4)'C'P(327,78)T(S3)'T'P(354,40)"
1390 PRINT "T(S8)'-'P(426,86)T(S2)'T'P(444,78)T(S3)'E'P(471,70)"
```

```
1400 PRINT "T(S4)'N'P(507,63)T(S5)'S'P(552,55)T(S6)'I'P(607,48)"
1410 PRINT "T(S7)'O'P(670,40)T(S8)'N'P(328,140)T(S4)'TEST'P(364,210)"
1420 PRINT "T(S4)'IN'P(238,280)T(S4)'PROGRESS...'";CHR$(27)+'\' \ RETURN
1430 ETIME(T9) \ T9=INT(T9+.5)
1440 TXTSPOS(,22,37) \ TXTINVERS \ PRINT " ";T9;" " \ TXTNORMAL \ RETURN
1450 REM  *** MAIN  — DITENS — Direct Tension Test ***
1460 DIM A1(750,3),A2(1,3),A3(1,3),M$(35),H2$(10),H3(10)
1465 FGSTOP \ ADSTOP
1470 CLRTXWIN \ TXTSPOS(,5,23) \ PRINT "MAKE SURE YOU ARE IN LOAD CONTROL!"
1480 TXTSPOS(,8,7) \ PRINT "Computer will take over the control of testing after
     you press <CR>."
1490 TXTSPOS(,9,8) \ PRINT "PLEASE DO NOT CHANGE MANUALLY ANY CONTROLLER
     SETTINGS AFTERWARDS!";
1500 INPUT #0:R$ \ IF R$<>"" THEN 1500
1510 GOSUB 2340
1520 CLRTXWIN \ E=VAL(L$(1)) \ M1=VAL(L$(2)) \ B1=7.00000E-03 \ L1=VAL(L$(4))
1522 R1=0.\ Z0=0 \ REM R1 indicates RMAX exceeded limit (.03)
1524 FOR I=0 TO 3 \ A1(1,I)=0 \ A2(1,I)=0 \ A3(1,I)=0 \ NEXT I
1526 A1(0,1)=0 \ A1(0,2)=0 \ A1(0,3)=0
1530 Z0=10^6/VAL(L$(5)) \ M2=VAL(L$(6)) \ F0=.5*E/(M1*10) \ E1=F0
1540 IF E>100 THEN E1=.01*F0 \ F0=E1
1550 IF E>10 THEN IF E<=100 THEN E1=.1*F0 \ F0=E1
1560 A5=VAL(J$(6)) \ CKTIME(1,INT((2.00000E-03+.1/E)*1000+.5)/1000,C1) \
     ADLEVEL(1,A1,,2,B1,1) \ ADSLAVE(1,5)
1570 ADRMAX(2,A2,2) \ ADSLAVE(2,1,5) \ ADRMIN(3,A3,2) \ ADSLAVE(3,1,5) \
     ADTRIGGER(3,,.03,1)
1580 IF E>100 THEN FGRAMP(1,18,E1)
1590 IF E>10 THEN IF E<=100 THEN FGRAMP(1,180,E1)
1600 IF E<=10 THEN FGRAMP(1,1800,E1)
1610 FGBUFEND(1,, LINE 2070 )
1620 TXTSPOS(,5,24) \ TXTBOLD \ PRINT "THIS IS A STROKE CONTROLLED TEST" \
     TXTNORMAL
1630 TXTSPOS(,7,17) \ TXTINVERS \ PRINT "VERIFY THAT THE CONTROLLER SETTINGS ARE
     CORRECT" \ TXTNORMAL
1640 TXTSPOS(,8,21) \ TXTINVERS \PRINT "BE SURE THAT STROKE AND LOAD
     ARE ZEROED" \ TXTNORMAL
1650 TXTSPOS(,10,9) \ PRINT "The test will be carried out successfully if the specimen
     does"
1660 TXTSPOS(11,9) \ PRINT "not crack before the load reaches 3% F.Scale.  Failure is
     defined"
1670 TXTSPOS(,12,9) \ PRINT "by a load reading of less than 2.5% F.Scale after load has
     exceeded"
1680 TXTSPOS(,13,29) \ PRINT "3% F.Scale (in tension)."
1690 TXTSPOS(,19,31) \ PRINT "NOW LOAD IS ZEROED."
```

```
1700 TXTSPOS(,20,22) \ PRINT "TO START TEST - ENTER 'GO', PLEASE: "; \ INPUT #0:R$
1710 IF R$<>'GO' THEN 1700
1720 PRINT CHR$(27)&"(?25l" \ GOSUB 1360
1730 ADINIT \ ADGO \ FGGO
1740 ETIME \ TXTSPOS(,23,33) \ PRINT 'ELAPSED TIME (s)'
1742 TXTSPOS(,16,15) \ TXTINVERS \ PRINT "ESC-Q" \ TXTNORMAL \ TXTSPOS(,16,60) \
     TXTINVERS \ PRINT "ESC-B" \ TXTNORMAL
1745 TXTSPOS(,18,9) \ PRINT "( QUIT the test )" \ TXTSPOS(,18,51) \ PRINT
     "( BREAK the specimen )"
1750 IF ELEVEL(A2(1,1))<.03 THEN 1750
1760 R1=1
1770 GOSUB 1430
1780 IF ELEVEL(A3(1,1))=0 THEN 1770
1790 IF R1*ELEVEL(A3(1,1))>.025 THEN 1770
1800 FOR J=1 TO 10000/E \ NEXT J
1810 GOSUB 1430
1820 IF ELEVEL(A3(1,1))<.025 THEN 1840
1830 GO TO 1790
1840 ADIMMED(1,S1) \ ADIMMED(2,Z6) \ ADIMMED(5,Z7)
1850 FGSTOP \ ADSTOP \ FGIMMED(1,"S", TIME 2,.75)
1860 ETIME(T9) \ GTIME(E7,E8,E9)
1870 CLRTXWIN \ TXTSPOS(,2,32) \ TXTBOLD \ PRINT "NEWS IN BRIEF..." \ TXTNORMAL
1880 TXTSPOS(,4,10) \ PRINT "TEST TERMINATED AFTER:    ";T9;
     "secs (";INT((T9/3600)*1000+.5)/1000;"hrs)"
1890 ETIME
1900 TXTSPOS(,5,10) \ PRINT "STROKE AT ULTIMATE LOAD = ";ELEVEL(A2(1,2))*10*M1;"mm"
1910 TXTSPOS(,6,10) \ PRINT "ULTIMATE LOAD DETECTED =  ";ELEVEL(A2(1,1))*L1*10;"N"
1920 TXTSPOS(,7,10) \ PRINT "STRAIN AT ULTIMATE LOAD = ";
     ELEVEL(A2(1,3))*10*M2*Z0;"mistrains"
1930 TXTSPOS(,9,10) \ PRINT "STROKE AT THE END OF TEST = ";
     ELEVEL(A3(1,2))*10*M1;"mm"
1940 TXTSPOS(,10,10) \ PRINT "LOAD AT THE END OF TEST =   ";ELEVEL(A3(1,1))*L1*10;"N"
1950 TXTSPOS(,11,10) \ PRINT "STRAIN AT THE END OF TEST = ";
     ELEVEL(A3(1,3))*10*M2*Z0;"mistrains"
1960 TXTSPOS(,12,10) \ PRINT
     "================================================="
1970 TXTSPOS(,13,10) \ PRINT "INITIAL LOAD READING:   ";ELEVEL(A1(0,1))*10*L1;"N"
1980 TXTSPOS(,14,10) \ PRINT "INITIAL STROKE READING: ";ELEVEL(A1(0,2))*10*M1;"mm"
1990 TXTSPOS(,15,10) \ PRINT "INITIAL STRAIN READING: ";
     ELEVEL(A1(0,3))*10*M2*Z0;"mistrains"
2000 TXTSPOS(,18,33) \ PRINT "<CR> TO PROCEED "; \ INPUT #0:R$
2010 CLRTXWIN \ TXTSPOS(,10,16) \ PRINT "PLEASE TYPE 'RETURN' TO ZERO THE STROKE: ";
2020 INPUT #0:R$ \ IF R$<>"RETURN" THEN 2010
2030 A=SYS(7) \ FGIMMED(1,"S", TIME 10,0)
```

```
2040 TXTSPOS(,22,26) \ PRINT "<CR> TO DISPLAY TEST RESULTS"; \ INPUT #0:R2$
2050 IF R2$<>"" GO TO 2040
2060 PRINT CHR$(27)&"(?25h" \ A=SYS(7) \ GO TO 2110
2070 FGREAD(1,E0) \ E1=E0+F0 \ IF E>100 THEN FGRAMP(1,18,E1) \ RETURN
2080 IF E>10 THEN IF E<=100 THEN FGRAMP(1,180,E1) \ RETURN
2090 IF E<=10 THEN FGRAMP(1,1800,E1) \ RETURN
2100 FGSTOP \ ADSTOP \ FGIMMED(1,'R', TIME 5,0) \ GO TO 1200
2110 GOSUB 2320
2120 GDATE(D9,M9,Y9) \ V1$=STR$(D9) \ V2$=STR$(M9) \ V3$=STR$(Y9)
2130 TXTSPOS(,1,28) \ TXTBOLD \ PRINT "T E S T  R E S U L T S" \ TXTNORMAL
2140 TXTINVERS \ PRINT " No.| TIME,s | LOAD,N | STROK,mm | STRAIN,ms | STRESS,kPa
     | STIFFNESS,MPa" \ TXTNORMAL
2150 TXTSCROLL(,3,22) \ TXTSPOS(,24,33) \ PRINT "<CR> TO CONTINUE"
2160 IF A1=0 THEN TXTSPOS(,5,25) \ TXTFLASH \ PRINT "SORRY, NO RESULTS. TEST FAILED."
     \ TXTNORMAL \ GO TO 2300
2170 TXTSPOS(,3,1) \ CURLIMON(1) \ A0=0
2180 FOR I=1 TO A1 \ A0=A0+A1(I,0)
2190 Q1=INT(A0*C1*1000+.5)/1000 \ Q2=(ELEVEL(A1(I,1))-ELEVEL(A1(0,1)))*10*L1
2200 Q3=ABS(ELEVEL(A1(I,2))-ELEVEL(A1(0,2)))*10*M1
2210 Q4=ABS(ELEVEL(A1(I,3))-ELEVEL(A1(0,3)))*10*M2*Z0
2220 Q5=10^3*Q2/A5 \ Q6=(Q5/Q4)*10^3 \ Q2=INT(Q2+.5) \
     Q3=INT(Q3*10000+.5)/10000
2230 Q4=INT(Q4+.5) \ Q5=INT(Q5+.5) \ Q6=INT(Q6*100+.5)/100
2240 TXTSPOS(,I,1) \ PRINT USING "-## |-##### | -#### | -##.#### | -###### |
       -###### | -#.####^^^^^",I,Q1,Q2,Q3,Q4,Q5,Q6;
2250 IF I/20<>INT(I/20) THEN PRINT
2260 IF I/20=INT(I/20) THEN INPUT #0:R$
2270 NEXT I
2280 INPUT #0:R$ \ IF R$<>"" THEN 2280
2290 CURLIMOFF(1) \ TXTSCROLL(1,1,24) \ GO TO 1200
2300 TXTSPOS(,10,15) \ PRINT "Press <CR> to get test menu, any other key to quit: ";
2310 INPUT #0:R$ \ IF R$<>"" THEN 1290
2315 GO TO 1200
2320 U0=A5*10*M2*Z0*(ELEVEL(A2(1,3))-ELEVEL(A1(0,3)))
2330 U0=((10^7)*L1*ELEVEL(A2(1,1)))/U0 \ U0=ABS(INT(U0*100+.5)/100) \ CLRTXWIN \
     RETURN
2340 REM
2350 CLRTXWIN \ TXTSPOS(,15,16) \ PRINT "VERIFY THAT MODE BOX SWITCH IS IN
     REMOTE POSITION"
2360 TXTSPOS(,16,20) \ TXTBOLD \ PRINT "SWITCH TO STROKE CONTROL MODE WILL
     FOLLOW" \ TXTNORMAL
2370 A=SYS(8) \ TXTSPOS(,19,33) \ PRINT "ENTER 'SW': "; \ INPUT #0:R$
2380 IF R$="SW" THEN ADIMMED(1,W1) \ ADIMMED(2,W2)
2390 IF R$<>"SW" THEN 2370
```

```
2400 FGHOLD \ MODESW(1,3,M9) \ PRINT CHR$(7)
2410 FOR I=1 TO 1000 \ NEXT I
2420 ADIMMED(1,W3) \ W4=W3-W1 \ IF M9=1 THEN FGRESUME \ GO TO 2450
2430 TXTSPOS(,22,31) \ TXTFLASH \ PRINT "MODE SWITCH FAILED" \ TXTNORMAL \
     INPUT #0:R$
2440 GO TO 2350
2450 ADIMMED(1,W6) \ ADIMMED(2,W5)
2460 CLRTXWIN \ TXTSPOS(,1,25)\ TXTINVERS \  PRINT "ZEROING THE LOAD - PLEASE
     WAIT..." \ TXTNORMAL
2470 FGIMMED(1,"S", TIME 5,0)
2480 FGREAD(1,W7) \ IF W7>0 THEN 2480
2490 RETURN
2550 REM Test results - Saving Subr
2560 CLRTXWIN \ IF Z0=.99 THEN PRINT TAB(21)"TEST RESULTS ARE SAVED ALREADY!" \
     INPUT #0:R$ \ GO TO 1200
2570 OPEN "TSTC" AS FILE #1
2580 FOR I=1 TO 7 \ INPUT #1:H2$(I) \ INPUT #1:H3(I)
2590 IF H2$(I)="DTT" THEN H3(I)=H3(I)+1 \ T4=H3(I)
2600 NEXT I
2610 CLOSE #1
2620 F2$=SEG$(STR$(H3(1)),1,3) \ F2$="DTT"+F2$+".MTS" \ OPEN F2$ FOR OUTPUT AS FILE
     #2, FILESIZE 4, ERROR A9
2630 M$(1)=SEG$(J$(5),1,2)+"("+SEG$(J$(5),3,6)+")" \ M$(2)=STR$(T4) \
     M$(3)=V2$&"/"&V1$&"/"&V3$
2635 M$(4)=SEG$(J$(2),1,1)+"."+SEG$(J$(2),2,2)+"."+SEG$(J$(2),3,5)+"."+SEG$(J$(2),6,7)+
     "."+SEG$(J$(2),8,10)
2640 M$(5)=SEG$(J$(3),1,2)+"/"+SEG$(J$(3),3,4)+"/"+SEG$(J$(3),5,6)
2645 M$(6)=SEG$(J$(4),1,1)+"-"+SEG$(J$(4),2,3)+"-"+SEG$(J$(4),4,6)
2650 M$(7)=J$(7) \ M$(8)=J$(8) \ M$(9)=SEG$(J$(1),1,4)+"."+SEG$(J$(1),5,7)+"."+
     SEG$(J$(1),8,10)
2655 M$(10)=J$(9) \ M$(11)=J$(10)
2660 M$(12)=L$(4) \ M$(13)=L$(2) \ M$(14)=L$(6) \ M$(15)="0.0" \ M$(16)=L$(3)
2670 M$(17)=L$(7) \ M$(18)=L$(1) \ M$(19)=J$(6) \ M$(20)=L$(5)
2680 L2$=STR$(INT(ELEVEL(A2(1,2))*10000*M1+.5)/1000) \ M$(21)=L1$ \ REM Stroke
2690 L3$=STR$(INT(ELEVEL(A2(1,3))*10*M2*Z0+.5)) \ M$(22)=L2$ \ REM Strain
2700 L4$=STR$(INT(((10^6)*VAL(L1$)/A5)+.5)) \ M$(23)=L3$ \ REM Stress in kPa
2710 L5$=STR$(INT(1000*VAL(L4$)/(ABS(VAL(L3$)-
     ELEVEL(A1(0,3))*10*M2*Z0)))+.5)\ M$(24)=L4$ \ REM Stiffness, MPa
2720 L8$=STR$(INT(ELEVEL(A3(1,1))*10*L1+.5)) \ M$(25)=L5$ \ REM Load @ failure
2730 L6$=STR$(INT(ELEVEL(A3(1,2))*10000*M1+.5)/1000) \ M$(26)=L8$ \ REM Stroke @
     failure
2740 L7$=STR$(INT(ELEVEL(A3(1,3))*10*M2*Z0+.5)) \ M$(27)=L6$ \ REM Strain @ failure
2745 M$(28)=L7$ \ M$(29)=STR$(T9) \ REM Test duration (s)
```

```
2750 M$(30)=SEG$(M4$,1,32) \ M$(31)=SEG$(M4$,33,64) \M$(32)=SEG$(M4$,65,96) \
     M$(33)=SEG$(M4$,97,127)
2760 FOR I=0 TO 33 \ PRINT #2,USING
     "<################################",M$(I) \ NEXT I \ REM 32-chars
2770 PRINT #2,"{{0}}" \ CLOSE #2
2780 TXTSPOS(,10,18) \ TXTINVERS \ PRINT "TEST RESULTS SAVED IN FILE:";F2$
2790 Z0=.99 \ TXTNORMAL \ INPUT #0:R$
2800 GO TO 1200
2810 END
```

# EXAMPLES OF INPUT TO THE PROGRAM and CORRESPONDING TEST RESULTS

## USER'S INPUT TO THE PROGRAM - Example 1

*SCREEN 1*

```
                    SAMPLE IDENTIFICATION

(1)  PAVEMENT SAMPLE ID.(Format: A999999X99): A401311A05
(2)  SPECIMEN ID.(Format: AAX99XA999):        PIA02AA311
(3)  DATE OF SAMPLE (Format: MMDDYY):         260392
(4)  MIX DESIGN ID.(Format: AA9999):          SH1000
(5)  TEST ID.(Format: AA9999):                DT0003
(6)  SPEC.CROSS-SECT.(mm^2):                  5320
(7)  SPECIMEN HEIGHT(mm):                     103
(8)  SPECIMEN WIDTH(mm):                      79
(9)  SPECIMEN MASS (kg):                      -----
(10) DISTANCE FROM PAVEMENT EDGE (m):         -----

                    ANY CHANGES? Y/N: N
```

*SCREEN 2*

```
                    TEST SPECIFICATIONS

(1) EXTENSION RATE(mm/hr):                    1.8
(2) STROKE CALIBRATION FACTOR(mm/V):          1.27
(3) TEST TEMPERATURE(C):                      -35
(4) LOAD CALIBRATION FACTOR (N/volts):        4448
(5) LVDT CLAMPS SPACING(mm):                  103
(6) STRAIN CALIBRATION FACTOR (mm/Volt):      .960
(7) TEST HUMIDITY (%):                        45

                    ANY CHANGES? Y/N: N
```

## TEST RESULTS - Example 1

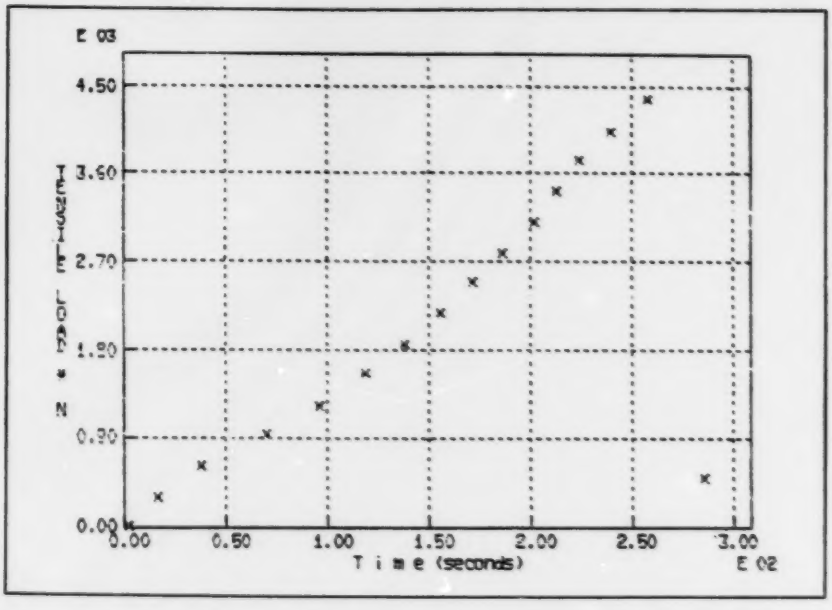
```
                    NEWS IN BRIEF...

TEST TERMINATED AFTER:      293.933 secs ( .082 hrs)
STROKE AT ULTIMATE LOAD =  .0182248 mm
ULTIMATE LOAD DETECTED =   4622.92 N
STRAIN AT ULTIMATE LOAD = -88.2181 mistrains

STROKE AT THE END OF TEST =  .0248168 mm
LOAD AT THE END OF TEST =    415.574 N
STRAIN AT THE END OF TEST = -941.942 mistrains
================================================
INITIAL LOAD READING:   -67.9043 N
INITIAL STROKE READING: -.117104 mm
INITIAL STRAIN READING:  48.3777 mistrains
```

TEST RESULTS

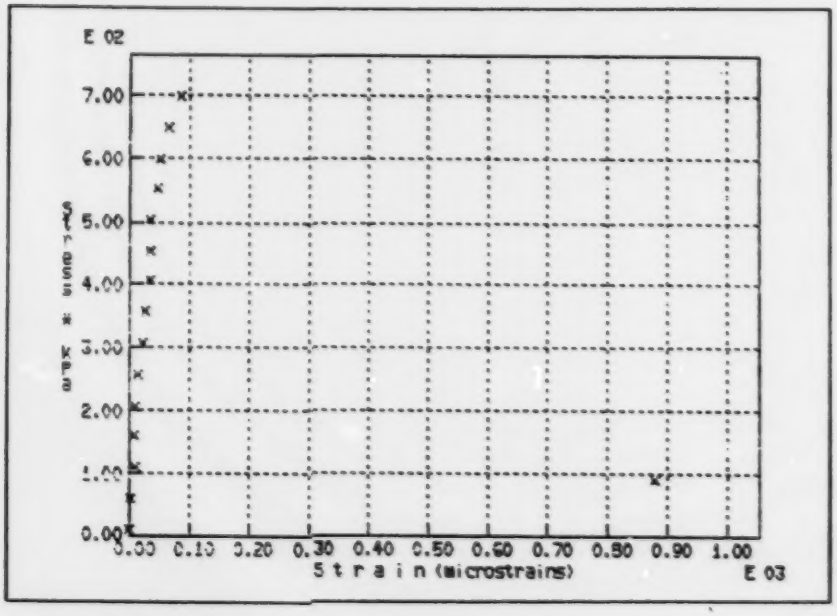
| No. | TIME,s | LOAD,N | STROKE,mm | STRAIN,mε | STRESS,kPa | STIFFNESS,MPa |
|---|---|---|---|---|---|---|
| 1 | 2.7 | 68 | 0.0027 | 0 | 11 | 1.0744 E+4 |
| 2 | 16.8 | 387 | 0.0093 | 3 | 61 | 2.1521 E+4 |
| 3 | 37.9 | 698 | 0.0217 | 11 | 110 | 9.7032 E+3 |
| 4 | 70.1 | 1004 | 0.0368 | 9 | 159 | 1.8601 E+4 |
| 5 | 96.1 | 1315 | 0.0496 | 11 | 208 | 1.8274 E+4 |
| 6 | 118.4 | 1632 | 0.0593 | 14 | 258 | 1.8153 E+4 |
| 7 | 138.4 | 1942 | 0.0682 | 23 | 307 | 1.3498 E+4 |
| 8 | 155.9 | 2263 | 0.0760 | 26 | 358 | 1.3978 E+4 |
| 9 | 171.7 | 2565 | 0.0845 | 34 | 406 | 1.1887 E+4 |
| 10 | 186.8 | 2867 | 0.0907 | 34 | 454 | 1.3284 E+4 |
| 11 | 202.3 | 3181 | 0.0985 | 34 | 503 | 1.4737 E+4 |
| 12 | 212.6 | 3490 | 0.1047 | 46 | 552 | 1.2129 E+4 |
| 13 | 224.2 | 3803 | 0.1121 | 51 | 602 | 1.1746 E+4 |
| 14 | 240.2 | 4111 | 0.1183 | 65 | 650 | 9.9380 E+3 |
| 15 | 258.3 | 4437 | 0.1272 | 85 | 702 | 8.2232 E+3 |
| 16 | 286.3 | 573 | 0.1493 | 879 | 91 | 1.0313 E+2 |

<CR> TO CONTINUE

***TENSILE LOAD as a FUNCTION of TIME***




***STRESS vs STRAIN***



## TEST REPORT - Example 1

```
                              TEST REPORT
-------------------------
** DIRECT TENSION TEST **                    DATE OF TEST: 26-Mar-92
-------------------------                    THURSDAY *  14 : 47 : 16
                                             TEST ID.: DT0003

SAMPLE IDENTIFICATION
1.PAVEMENT SAMPLE ID.: A401311A05    5.DATE OF SAMPLE:       260392
2.SPECIMEN ID.:        P1A02AA311    6.MIX DESIGN ID.:       SH1000
3.SPECIMEN HEIGHT(mm): 103           7.SPEC.CROSS-S.(mm^2): 6320
4.SPECIMEN WIDTH (mm): 79            8.SPECIMEN MASS (kg):

TEST PARAMETERS
1.EXTENSION RATE(mm/hr): 1.8         3.TEST HUMIDITY (%):       45
2.TEST TEMPERATURE(C):   -35         4.LVDT CLAMPS SPACING(mm): 103

TEST RESULTS
1.ULTIMATE TENSILE LOAD (kN) =       4.623
2.STIFFNESS AT ULTIMATE LOAD (MPa) = 5.3550 E+3

NOTES (<128 characters): Broken very close to the upper "glue" line.
```

## USER'S INPUT TO THE PROGRAM - Example 2

*SCREEN 1*

```
                    SAMPLE IDENTIFICATION

(1)  PAVEMENT SAMPLE ID.(Format: A999999X99): B305411A06
(2)  SPECIMEN ID.(Format: AAX99XA999):        CIB05AB702
(3)  DATE OF SAMPLE (Format: MMDDYY):         012292
(4)  MIX DESIGN ID.(Format: AA9999):          SH0311
(5)  TEST ID.(Format: AA9999):                DT0009
(6)  SPEC.CROSS-SECT.(mm^2):                  5928
(7)  SPECIMEN HEIGHT(mm):                     101
(8)  SPECIMEN WIDTH(mm):                      77
(9)  SPECIMEN MASS (kg):                      ------
(10) DISTANCE FROM PAVEMENT EDGE (m):         ------

ANY CHANGES ? (Y/N)
```

*SCREEN 2*

```
                    TEST SPECIFICATIONS

(1) EXTENSION RATE(mm/hr):                    300
(2) STROKE CALIBRATION FACTOR(mm/V):          1.27
(3) TEST TEMPERATURE(C):                      21
(4) LOAD CALIBRATION FACTOR (N/volts):        2224
(5) LVDT CLAMPS SPACING(mm):                  101
(6) STRAIN CALIBRATION FACTOR (mm/Volt):      .960
(7) TEST HUMIDITY (%):                        35

ANY CHANGES?(Y,N): N
```

**TEST RESULTS** - **Example 2**

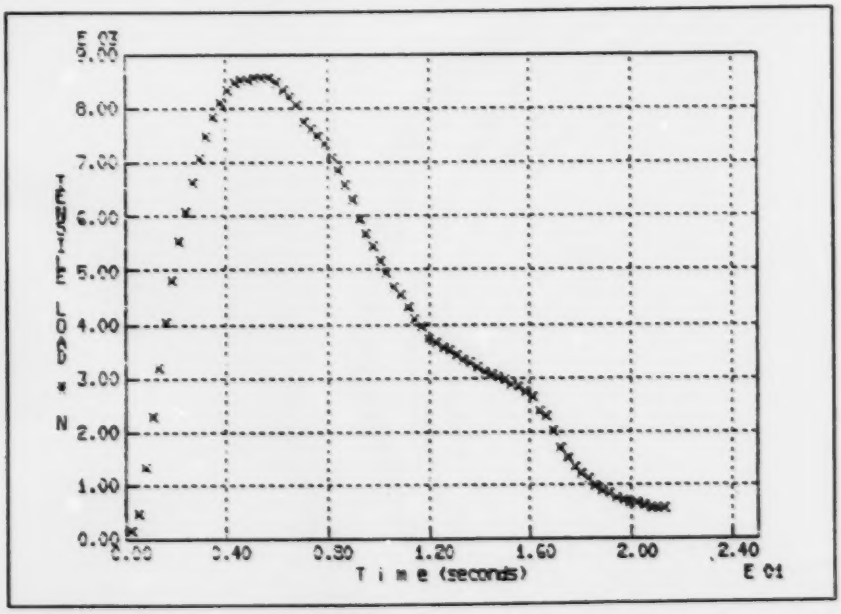
```
                        NEWS IN BRIEF...

TEST TERMINATED AFTER:      23.7833 secs ( 7.0E-03 hrs)
STROKE AT ULTIMATE LOAD =   .455233 mm
ULTIMATE LOAD DETECTED =   *8568.84 N
STRAIN AT ULTIMATE LOAD = -2539.34 mistrains

STROKE AT FAILURE =  1.95394 mm
LOAD AT FAILURE =     523.542 N
STRAIN AT FAILURE = -17853.7 mistrains
================================================
INITIAL LOAD READING:    34.6312 N
INITIAL STROKE READING: -.022878 mm
INITIAL STRAIN READING:  46.4336 mistrains
```

TEST RESULTS

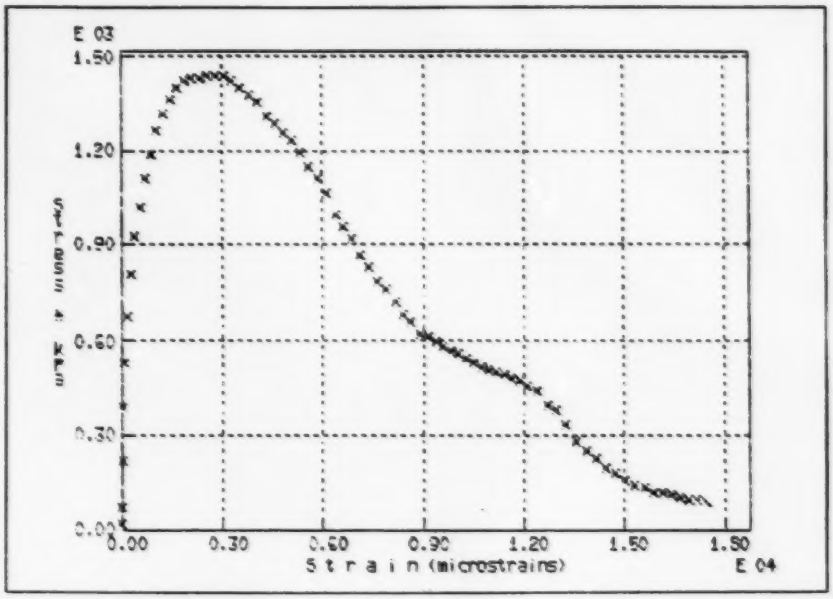
| No. | TIME,s | LOAD,N | STROK,mm | STRAIN,mm | STRESS,kPa | STIFFNESS,kPa |
|---|---|---|---|---|---|---|
| 9 | 2.6 | 6071 | 0.2253 | 583 | 1024 | 1.7556 E+3 |
| 10 | 2.8 | 6634 | 0.2501 | 728 | 1119 | 1.5362 E+3 |
| 11 | 3.1 | 7083 | 0.2749 | 897 | 1195 | 1.3324 E+3 |
| 12 | 3.4 | 7501 | 0.3001 | 1068 | 1265 | 1.1849 E+3 |
| 13 | 3.7 | 7825 | 0.3253 | 1268 | 1320 | 1.0409 E+3 |
| 14 | 3.9 | 8113 | 0.3509 | 1463 | 1369 | 9.3571 E+2 |
| 15 | 4.2 | 8333 | 0.3757 | 1657 | 1406 | 8.4831 E+2 |
| 16 | 4.4 | 8486 | 0.4013 | 1878 | 1432 | 7.6239 E+2 |
| 17 | 4.7 | 8521 | 0.4262 | 2101 | 1437 | 6.8409 E+2 |
| 18 | 5.0 | 8532 | 0.4514 | 2336 | 1439 | 6.1609 E+2 |
| 19 | 5.3 | 8560 | 0.4766 | 2563 | 1444 | 5.6350 E+2 |
| 20 | 5.5 | 8564 | 0.5022 | 2815 | 1445 | 5.1320 E+2 |
| 21 | 5.8 | 8558 | 0.5270 | 3047 | 1444 | 4.7376 E+2 |
| 22 | 6.0 | 8459 | 0.5522 | 3279 | 1427 | 4.3512 E+2 |
| 23 | 6.3 | 8355 | 0.5782 | 3538 | 1409 | 3.9840 E+2 |
| 24 | 6.6 | 8217 | 0.6030 | 3802 | 1386 | 3.6461 E+2 |
| 25 | 6.9 | 8067 | 0.6278 | 4046 | 1361 | 3.3638 E+2 |
| 26 | 7.2 | 7772 | 0.6530 | 4339 | 1311 | 3.0217 E+2 |
| 27 | 7.4 | 7636 | 0.6790 | 4591 | 1288 | 2.8056 E+2 |

(CR) TO CONTINUE

***TENSILE LOAD as a FUNCTION of TIME***



***STRESS vs STRAIN***




**TEST REPORT - Example 2**

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                          TEST REPORT
-------------------------
** DIRECT TENSION TEST **                  DATE OF TEST: 22-Jan-92
-------------------------                  WEDNESDAY *  10 : 43 : 52
                                           TEST ID.: DT0009

SAMPLE IDENTIFICATION
1.PAVEMENT SAMPLE ID.: B305411A06    5.DATE OF SAMPLE:       012292
2.SPECIMEN ID.:        CIB05AB702    6.MIX DESIGN ID.:       SH0311
3.SPECIMEN HEIGHT(mm): 101           7.SPEC.CROSS-S.(mm^2): 5928
4.SPECIMEN WIDTH (mm): 77            8.SPECIMEN MASS (kg):  ------

TEST PARAMETERS
1.EXTENSION RATE(mm/hr): 300         3.TEST HUMIDITY (%):       35
2.TEST TEMPERATURE(C):   21          4.LVDT CLAMPS SPACING(mm): 101

TEST RESULTS
1.ULTIMATE TENSILE LOAD (kN) =       8.569
2.STIFFNESS AT ULTIMATE LOAD (MPa) = 5.5902 E+2

NOTES (<128 characters): Broken at 1/3rd of the upper end.
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